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STUDIES ON THE SETTLEMENT OF SPHAGNUM BULTS IN A HEATH BÒG BY COLLEMBOLA

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In the course of a documentation of landscapes destined for brown coal mining in the future we are investigating the springtail fauna of heath bogs in the Northern Oberlausitz (G.D.R.) since 1987. Some results from the greatest complex of these bogs, the Dubring bog near Hoyerswerda (330 hectare) are given here. On the bottom of old peat-cuttings of this bog great bog holes are developed which are overgrown with a Rhynchosporion association and are inundated by ground water with the exception of short dry periods. The ground water level is overtopped by isolated, 30 - 80 cm high Sphagnum bults each 50 - 150 cm in diameter. The bults are situated in a distance of 1 to 5 m from each other. Their structure is showed in Fig. 1 (after PIETSCH 1985 and in lt.). The springtail population was studied each month 1987/88 taking samples at 7 positiones (microhabitats) from 5 different bults:

0 Inundated (or at least wet) bog hole with Rhynchospora alba, Sphagnum cuspidatum; moderately acid, relatively rich in electrolytes

a, b Basal zone of bults with Sph. auriculatum, Sph. inundatum; wet due to the contact with the ground water; a southern, b northern part of bults

c Lower medial zone with Sph. angustifolium; lasting humid, still with capillary contact to the ground water, more acid, poorer in electrolytes; northern part of bults

d Upper medial zone with Sph. papillosum overgrowing other mosses; extremely acid, exclusively ombrotrophic and therefore changing between humid and fresh; southern part of bults

e Upper zone of bults with Sph. compactum, on older and higher bults Calluna vulgaris, Erica tetralix or Pinus sylvestris start to settle; periodically dry, fresh or humid resp.

f Inner part of bults, upper medial zone, consisting of dead plants of Sph. papillosum or angustifolium.

Within the whole complex of bog holes and bults we found 60 species of Collembola. Only few species prefered the bog holes or the water surface: Podura aquatica, Isotomurus palustris, Sminthurides malmgreni (spring), Sm. schoetti (winter). The majority of the species are bult inhabitants. These we studied in detail.

Eight species occur numerously and regularly in the Sphagnum bults. They exhibit preferences to different zones as it is shown by the relative abundances at the basal and upper zones resp. (Table 1).

Table 1. Relative abundance (%) in Sphagnum bults

	basal zone	upper zone
Proisotoma crassicauda	90,3	4,7
Ceratophysella scotica	37,7	59,1
Isotoma olivacea	33,6	66,3
Isotoma viridis	20,4	78,6
Friesea mirabilis	19,2	79,6
Ceratophysella succinea	18,3	80,5
Folsomia manolachei	10,2	88,4
Micranurida pygmaea	4,4	96,0

The key factor of the different behaviour will primarily be the moisture. Other ecological factors which are shown in Fig. 1 are correlated with the degree of moisture, esp. acidity and Ca^{++} content. They are not thought to have a direct influence to the distribution behaviour within the

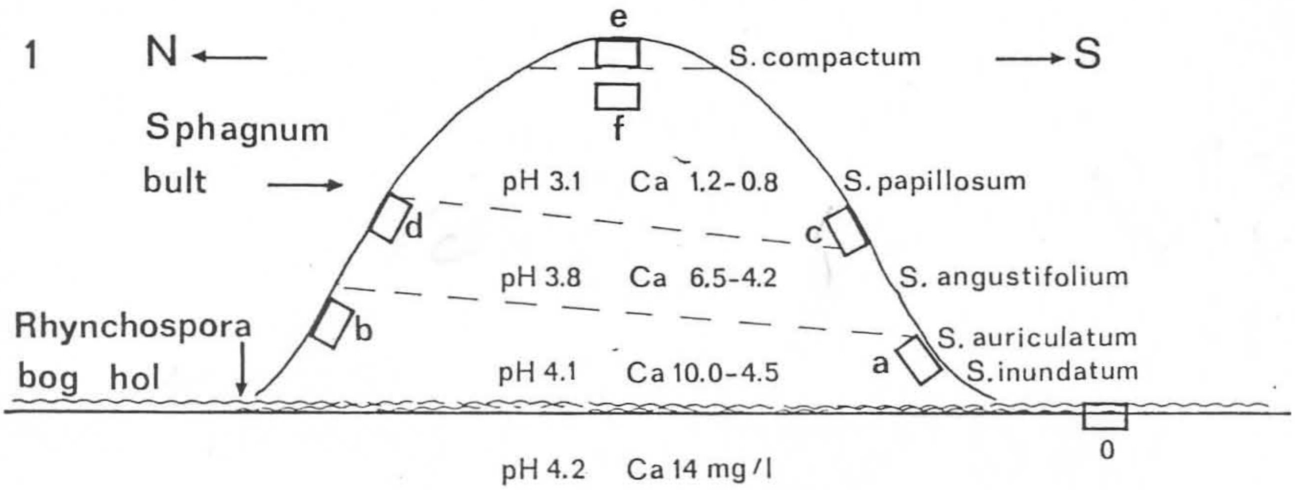


Fig. 1 Ecological characterization of a Sphagnum bult

bults. On the other hand the development of microorganisms will be widely dependent on these factors but is not studied itself. Therefore we have tried to get some information by investigation of the gut contents of Collembola. The results are not very satisfactory. It can be summarized that most of the species eat hyphae, spores, algae, pollen and dead organic material, but the gut fillings show a great individual (intraspecific) variation. Large specimens of Isotoma viridis have a greater proportion of leaf tissue of Sphagnum mosses or even show a carnivorous nutrition as do Friesea mirabilis. A reliable statement of possible specific differences of nutrition must be worked out separately.

The temperature factor, too, can be estimated only roughly. At the surface of the southern exposed upper parts of the bults the temperatures climb over 50°C under the condition of sunshin and dryness. Differences up to 30 K between the southern and the northern parts of bults could be registered. Therefore we compared the population densities of Collembola with regard to the exposition during May - June, e.g. the period with the highest temperature differences and - partly - with the maxima of Collembola density. The results (Table 2) show a different behaviour of some species at the lower (moist) parts of the

Table 2. South preference factor
(density at southern : northern parts of bults)

	basal zone	medial zone
Isotoma viridis	0,5	0,8
Friesea mirabilis	0,7	0,7
Ceratophysella scotica	0,3	1,3
Folsomia manolachei	0,6	1,1
Proisotoma crassicauda	1,0	-
Ceratophysella succinea	2,6	1,3
Micranurida pygmaea	(22,6)	1,0

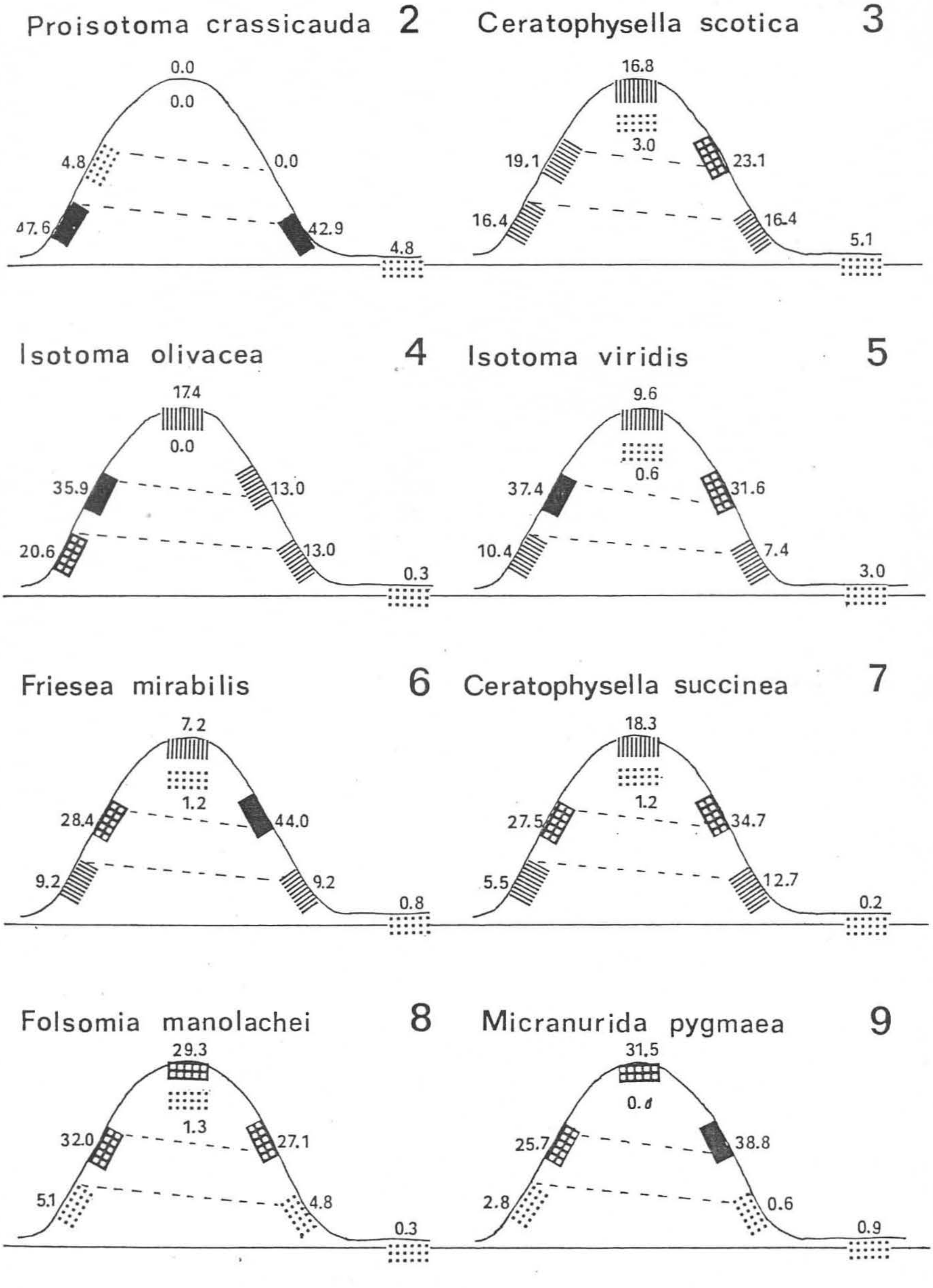
bults compared with the upper (drier) parts. Ceratophysella succinea and Micranurida pygmaea seem to prefer distinctly the southern slope of the bults. The other species avoid more or less microhabitats with higher temperatures or are indifferent.

In connection with these observations the fact is very important that no one of the 8 species displaies a discernible migration within the bults. Probably the chaotic network of moss stems renders it difficult to move directly in a range of decimeters. Therefore migration seems to be restricted on a millimeter range at the outer layer of the bult to avoid heat and dryness.

The populations of the 8 most numerous species are distributed in the bult microhabitats as follows.

Proisotoma crassicauda (Fig. 2) most clearly prefers wet microhabitats and is hardly to be found in the humid medial zone. Juvenils occur from May, adults from September - October. During the winter, single adult specimens could be observed on the water surface or at the basis of bults. The new generation starts at the beginning of May. The population is hardly divided in isolated parts inhabiting single bults because the wet bog holes are no hindrance for spreading to this species.

Ceratophysella scotica (Fig. 3) has a similar distribution behaviour as P. crassicauda with the exception that


Proisotoma crassicauda 2

Ceratophysella scotica 3

Isotoma olivacea 4

Isotoma viridis 5

Friesea mirabilis 6

Ceratophysella succinea 7

Folsomia manolachei 8

Micranurida pygmaea 9

Fig.2-9 Average relative abundance at 7 positions of bults

C. scotica settles the whole bult. The species can be found throughout the year, adults mostly during autumn and winter. C. scotica is able to overcome the wet bog holes as does P. crassicauda.

Isotoma olivacea (in the sense of FJELLBERG 1979; Fig. 4) is an extreme winter species being proved between November and April only. It is cold stenothermous and univoltine with short duration of the development. I. olivacea settles all parts of the bults showing a preference to the not wet (or not freezed) places. Single specimens could be observed on the bog holes, too.

Isotoma viridis (Fig. 5) prefers more clearly the medial zone of bults. On the other hand it is able to move on the water surface. Therefore the population is hardly divided in one-bult-restricted parts. I. viridis is active throughout the year. Adults are rare during spring but dominate during autumn. From December to April single adult specimens could be found only. Probably the eggs are layed during this period.

Friesea mirabilis (Fig. 6) shows a habitat preference and population dynamic similar to I. viridis but differs by the nutrition and spreading, esp. in their absence at bog holes during the inundation time.

Ceratophysella succinea (Fig. 7) clearly avoids wet microhabitats. It regularly settles even the dry heath-like upper zone though not preferently. Juvenils and subadult specimens occur in high numbers during May and June. Later on adults are to be find in lower densities but are absent during winter. C. succinea seems to be univoltin in the bults.

Folsomia manolachei (in the sense of DEHARVENG 1982; Fig. 8) is the only Folsomia species living here. In the bults there are two generations per year only. Preferently the heath-like upper zone as well as the medial zone are settled. Each bult is supposed to shelter a relatively well isolated subpopulation of F. manolachei. No one specimen has been found in the bog holes between the bults.

Micranurida pygmaea (Fig. 9) exhibits most clearly a warmth preference or even some degree of drought tolerance. This species is active throughout the year and has two maxima of density (June and October-November). There is no distinct delimitation between generations.

Other species which inhabit the bults are much less numerous. Among these Tetracanthella arctica (winter) and Mesaphorura yosii prefer the medial bult zone, Onychiurus (P.) vanderdrifti the inner parts of the bults. The upper zone with tendency to heath-like conditions is additionally settled by Mesaphorura sylvatica, Neanura muscorum, Pseudosinella alba, Entomobrya nivalis and multifasciata and Anurophorus laricis.

The detailed study of the distribution of 8 species populations at different microhabitats of the Sphagnum bults allows the conclusion, that their niches ared different in space as well as in time and perhaps in nutrition. The investigation of bults which are relatively isolated by inundated bog holes gives a good possibility to compare the behaviour of different species living cloth together under apparently "the same" conditions. It must be taken in consideration however that some of the studied species may be in a kind of stress within the restricted bult microhabitats and therefore possibly do not realize their whole and normal ecological potency.

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